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official duties, and perhaps also his advancing years, restricted somewhat his contributions to the American Association. In 1881 he presented papers to the Association at its Cincinnati meeting; in 1882 he was President of Section I., and delivered an address upon Economic Science and Statistics; and in 1886 he made the last of his many contributions, at the Buffalo meeting, in a paper dealing with the rate of interest realized to investors in government securities, and offering formulas for determining the United States gold value of silver bullion, when the London price per ounce of standard silver and the price of Sterling Exchange between New York and London are known.

His last scientific work was in connection with the Metrological Society, in 1887. The second volume of the Proceedings of that Society contains several communications from his pen.

Mr. Elliott reached the close of his busy and useful life, at Washington, on May 24, 1888, in his sixty-third year. He was never married.

This brief review of his numerous and varied works fully justifies the conclusion that he was among the most meritorious of American statisticians and actuaries. Personally, Mr. Elliott was one of the most amiable of men, with a childlike simplicity of character and utterly incapable of offence or of guile.

FOREIGN HONORARY MEMBERS.

MICHEL EUGÈNE CHEVREUL.

Michel Eugène Chevreul died in Paris, April 9, 1889. He was born at Angers, on a branch of the Loire, August 31, 1786. The mere fact that any one prominent in the world of science should have lived to the extraordinary age of almost one hundred and three years is in itself so surprising and unprecedented that our thoughts tend to dwell upon it unduly. A moment's reflection is needed to bring into clear light the deeds of merit which made the man illustrious. It is to be remembered that Chevreul was the contemporary of chemists who died when most of us here present were children or not yet born. The friends of his youth were Ampère and Gay-Lussac, D'Arcet, Davy, Oersted, Wollaston, and Berzelius. Proust was his townsman, Vauquelin was his teacher, and it is evident that Fourcroy also had no little influence upon his scientific life.

With Cuvier and with Ampère, as he tells us, he was accustomed to hold unending friendly debates upon plans of classification and upon the aims and methods of scientific research. Years after Chevreul had been left the sole survivor of the chemists of his time, he was accustomed, in his lectures at the Gobelins, to make fond allusion to the works of these men, almost as if they had been still alive. Chenevix, also, as he assured us, "was a very conscientious man, with immense encyclopedic knowledge."

It is said that Chevreul's early education was carefully looked to by his father, who was a distinguished physician. Between the ages of eleven and seventeen the boy studied at the École Centrale of Angers. He then went to Paris, where he immediately attracted the attention of his teachers. When twenty years old he was assistant in charge of Vauquelin's laboratory, and teacher in a scientific school which Fourcroy had founded. In this same year, 1806, he began to publish scientific papers, and before ten more years had passed it was recognized by every one that he had gained a place in the foremost rank of chemists. In 1810 he was appointed assistant naturalist at the Garden of Plants, and he subsequently succeeded to the Chair of Chemistry at the Garden, which had been occupied, successively, by Geoffroy, the Brothers Rouelle, Lemery, Macquer, Fourcroy, and Vauquelin. It is noticeable that no small part of Chevreul's work related to subjects in the domain of natural history, and that he published many papers in the Annales and Mémoires of the Museum. In 1816 he was appointed Professor of Chemistry at the Gobelins, and director of its dye-houses. In 1826 he became a member of the French Academy of Sciences and a foreign honorary member of the Royal Society of London.

As a chemist, Chevreul investigated a great variety of substances, ranging from the sugar of diabetes and the oxidation products of cork, on the one hand, to compounds of tungsten, uranium, and zirconium, on the other. He edited several scientific journals also, and contributed articles to encyclopædias and dictionaries of science and of technology. As an example of work of this kind may be cited a review written by him, in 1822, of a French translation of Sir Humphry Davy's Lectures on Agricultural Chemistry. This review is well worth reading to-day, and it has a certain historic interest, since it marks better even than the Lectures themselves the very considerable progress which had been made at that early period by chemists who sought to classify and explain the phenomena of vegetable growth by referring them to scientific principles.

At the very first, Chevreul devoted much attention to the investigation of the coloring matters in dye-woods, not because the subject was at that time in the line of his duty, but, apparently, because of the facility with which the materials could be procured. It has long been a maxim of the French chemists, that it is well for beginners in research to work upon some technical product, such as can readily be obtained at a manufactory, since by so doing much of the trouble and cost of procuring materials fit for investigation may be avoided. The results of several of these early investigations were valuable additions to scientific knowledge. It was Chevreul who discovered brazilin, white-indigo, and hæmatoxylin, — also creatin. But by far the most noteworthy of his works at this period was the classical research on the composition of fats, which was published in book form in 1823. He had been actively engaged in studying this subject during the years 1811 to 1820. Of this research chemists have always held one opinion, namely, that it was masterly. Hermann Kopp says of it, in his Geschichte der Chemie, "Chevreul's work on the fats is a model of a complete and exhaustive research in organic chemistry." It may well be said of it, that it gave to the world a new source of power, akin to those gained by the investigation of the properties of steam and of electricity. A great flood of light was thrown upon a matter of extreme darkness. By mere force of its clearness, the publication of this work led directly to numberless improvements in the arts and in household economy. At a time when methods of investigating organic substances were little known, this research brought out, as by a touch, complete, accurate, and enduring knowledge of the composition and properties of a large and important class of chemical substances, the study of which had previously been supposed to be peculiarly difficult. The research itself was thoroughly and purely scientific. As Kopp has set forth, it disclosed the proximate and ultimate composition of the fats, both in general and in particular, qualitatively and quantitatively, as well as the composition of the products of the decomposition of fats; it developed a rational theory as to the chemical structure of the fats, and displayed the relations which the fats bear to other chemical substances. Meanwhile, the processes of organic analysis which Chevreul used were decided improvements on those of his predecessors.

It is because of the purity and fulness of this particular fountain, so to say, of scientific knowledge, that so many useful technical applications have flowed from it. Even up to the present time it has exerted an enormous influence upon all that relates to the manufacture and use of soaps, oils, glycerine, and candles. Such familiar words as cholesterin, stearin, margarin, oleic acid, butyric acid, and the like, have come down to us from Chevreul's work. It is safe to say that, if the man had died in his fortieth year, his name and fame would still have been familiar to us.

Subsequently to his work upon the fats, Chevreul occupied himself with a great variety of chemical studies, and gave special attention to matters relating to dyeing and painting. It was at this epoch that he began his investigations of the laws of the harmony of colors. His book upon this subject, published in 1839, has been widely read, with no little interest, by several generations of men.

In studying the question of the harmony of colors, Chevreul was impressed with the importance of having a definite standard with which all colors could be compared, and by means of which all colors could be accurately named. He argued that in the technical application of colors, either for painting or dyeing, it is impossible to lay down definite rules for obtaining a desired result unless each of the colors to be employed can be accurately described. In order to do this, he devised his so called chromatic circle, which was manifestly a great improvement both upon the common practice of comparing colors with natural objects, and upon the ideas of several scientific men who have urged that definite standards of comparison might be chosen among colored minerals, or birds, or flowers. This chromatic circle well illustrates one peculiarity of Chevreul which was not a little conspicuous; namely, his leaning towards the methods of naturalists. He sought always to classify ideas and substances into families, genera, and species. He insisted on carefully distinguishing the chemical properties of bodies from their physical and organoleptic properties. To him the characteristic peculiarities of the "immediate principles" (proximate constituents) in a compound were of deeper interest than the question of their ultimate composition.

For the fundamental points of comparison in his circle of colors he chose from the solar spectrum definite rays of red, yellow, and blue, the position of each of which was marked by that of certain stated lines of Fraunhofer. These three colors were placed at equidistant points on the circle, and between each pair of them were intercalated twenty-three mixtures, so that the complete circle comprised seventy-two colors in all. For example, half-way between yellow and blue came green, and half-way between yellow and green came "yellow-green." But between yellow and yellow-green were five different tints, named yellow with green 1, or 2, or 3, or 4, or 5, respectively;

and so between blue and red, and between red and yellow. In addition to this "normal" circle, he had eight others, the colors of which were toned down, respectively, with one tenth, two tenths, three tenths, and so on, of black. In order to compare shades of colors, he prepared standard rows, or columns, by mixing his normal colors with one tenth, two tenths, and so on, of black in one direction, and with one tenth, etc. of white in the other. Chevreul's idea was that standard circles of color should be kept in the custody of public officers, just as standards of weights and measures are kept. But in seeking to carry out this scheme a grave difficulty is encountered in that most colors speedily fade. Moreover, while it is comparatively easy to compare colored threads with the colors of a circle made in silk or woollen, it would not be easy to compare colored woollen stuffs with the colors of a circle made of porcelain; that is to say, the varying lustres of colors, according as they have been put upon one or another kind of material, hinders very decidedly the accurate comparing of them. It is in fact difficult to compare the colors of metals or alloys with those of dyes fixed upon wool, or of pigments printed on paper. In the course of his lectures, Chevreul was accustomed to construct with skeins of worsted upon the floor of the great exhibition hall at the Gobelins a mammoth circle, which was an object of great beauty. It carried conviction to his audience that the device would be one of great practical utility, if it were but possible to obtain permanent colors with which to construct the circle.

It was in 1832 that Chevreul printed his first paper on the harmony of colors, and his book upon the subject was published seven years later, when he was fifty-three years old. He continued to write about the contrast of colors as long as he lived; but not with his old-time sagacity. It must be said, indeed, that, in spite of his very long life, the term of Chevreul's useful working years was practically no longer than that of many another scientific man whose life was shorter than his by a quarter of a century. Even in Chevreul's seventieth year it was very evident that he was already "a savant somewhat past his faculties."

During his declining years he had much to say, both by way of reclamation and of explanation, in favor of the views and labors of earlier investigators, and there can be no question that he held in mind many matters of historic interest; but, sad to say, in his enfeebled condition the task of putting these things in order was beyond his powers. Worst of all, perhaps, the ways of thinking of the new generations had become so unlike his ways that hardly any one could find time to give heed to what he had to say. Indeed, it is by no means easy, even if it be possible, to apprehend justly the import of some of his later views and statements. It may well be questioned whether the somewhat painful impression which must have been made upon his grandchildren and great-grandchildren by many of the utterances of Chevreul's last years does not explain the singular request made by them to the French Academy, that no eulogy should be pronounced upon their ancestor.

In many notices which have been printed since Chevreul's death stress has been laid, justly enough, upon the great influence which he exerted in the field of industrial chemistry. All this is true. Few men have had a wider influence than he for good in this department. On the approach of his hundredth birthday, it was suggested that there should be displayed to the public at the Garden of Plants specimens of the various products of industry which had been made better by means of his thoughts and studies. But this idea had to be given up, because not even the large new hall of the Zoölogical Museum could heve held all the materials which were offered for exhibition. In point of fact, on his hundredth birthday there came marching with banners into the great hall of the Museum, to do him honor, two thousand and more delegates from the learned societies, the schools, the museums, and the workshops in whose behoof he had labored so faithfully during many useful years. It should be borne in mind, none the less, that Chevreul was not an industrial chemist, in the modern acceptation of the term. It was not for money prizes that he lived and labored. But the brilliant technical results which followed the publication of his researches showed to all men what stores of wealth may be gained by the judicious application of scientific knowledge for the correcting of rules of art. In recent days there has been no lack of workers in this alluring field.

It is a matter of history that the influences of the Revolution, and of the succeeding long struggle between France and the rest of Europe, gave more or less of a practical or economic bias to the minds of most French teachers and scientific men of the period in which Chevreul's youth was passed. With his fellows, he felt the influence of the wars of the Revolution, and of the public feeling which found expression in the École Normale and the École Polytechnique. In this sense, it is true that he worked by preference upon subjects intimately connected with the ordinary affairs of life; but it should be remembered of him that he was not only an accomplished chemist, but always, from first to last, a thoroughly scientific man of an admirable type.